REMARKS

These remarks are in response to the Office Action dated June 29, 2005. In the Office Action, claims 1-56 stand rejected under 35 USC § 103. Applicants request that the following remarks be considered and that the rejections be reconsidered and withdrawn.

In the Office Action claims 1-6, 8, 11-23, 25, 26, 28-32, 34-37, 39, 42-48 and 50-56 were rejected as allegedly being unpatentable under 35 USC 103(a) over *Lee* (U.S. Patent 4,789,801) in view of *Natarajan* et al. (U.S. Patent 4,264,343). The Office Action took the position that *Lee* teaches all of the elements of the claimed invention except for "the driver electrode located between a pair of collector electrodes is not insulated" (Office Action, page 3) and relied on *Natarajan* to remedy the indicated deficiencies. The Office action stated:

> Natarajan shows in an electrostatic precipitator the provision that the electrode located between a pair of collector electrodes is insulated with a layer of dielectric material comprises of ceramic. (citation omitted) The subject matter as a whole would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified Lee's teachings as suggested by Natarayan because this would result in preventing sparking or arcing between the electrode and the collector electrodes and in achieving high electrostatic fields therebetween. (Office Action, page 3).

Of the rejected claims only Claims 1, 14, 19, 31, 34, 45, 50 and 53 are independent and each independent claim requires an insulated driver electrode in an electro-kinetic air transporter-conditioner system. Claim 49, which also is independent contains the same limitation. Applicants respectfully submit that the invention is not obvious because there is no motivation to combine *Lee* with *Natarajan* to arrive at the claimed invention. Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion or motivation to do so found either explicitly or implicitly in the references themselves or in the knowledge generally available to one of ordinary skill in the art. Moreover, the mere fact that the references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of making the combination.

Initially, it should be noted that the *Natarajan* device is not an electro-kinetic air transporter–conditioner system, as is the present invention. Rather, the *Natarajan* device is a particle precipitator for use in cleaning gas streams. *Natarajan* relies on the kinetic energy already present in a gas for gas movement through its device and does not appear to have any significant capability to impart kinetic energy to gases to cause them to move through its device. In contrast, the present electro-kinetic air transporter conditioner systems impart kinetic energy to air causing it to move through the device. The design considerations for an electro-kinetic air transporter-conditioner devices are distinct from those in precipitators and these differences are not trivial. When the gas entering a device, such as the *Natarajan* device, already has sufficient kinetic energy; the device is substantially more tolerant of components (and their dimensions) poisitoned in the gas stream. In an electro-kinetic device, which imparts a small amount of kinetic energy to a gas to move it through the device, there is little tolerance. Therefore, the art involved with particle precipitators is not generally useful to the art of electro-kinetic air transporter-conditioner systems.

It is partly for this reason that neither *Lee* nor *Natarajan* suggest the desirability of making their combination and that a person of ordinary skill in the art would not be motivated to make the combination so as to obtain the present invention. Further evidence of the nonobviousness of the combination is that *Natarajan* issued in 1981, six years before the *Lee* patent was filed. Should any advantage have been offered by the combination of *Natarajan* with *Lee*, then *Lee* could have incorporated any useful teachings of *Natarajan*. Clearly, no apparent advantage was apparent to *Lee* when the *Lee* application was filed in 1987.

Moreover, Applicants submit U.S. Application No. 60/369,554 to Lee ("*Lee-2*"), which was filed on April 1, 2002, as further evidence of nonobviousness. (See Tab A). In that application *Lee* again discloses various aspects of the use of a driver electrode in electro-kinetic air transporter-conditioner systems. Again, *Lee* does not disclose the use of insulated driver electrodes. Thus, as of April 1, 2002, more than 21 years after issuance of *Natarajan,* Lee himself did not teach or suggest that there would be any advantage to insulating its driver electrodes in electro-kinetic air transporter-conditioner systems. Nor is Applicant aware of anyone else who did. Since *Lee* did not teach or suggest the use of insulated driver electrodes, it simply cannot be said that one of ordinary skill in the art would have appreciated an advantage in

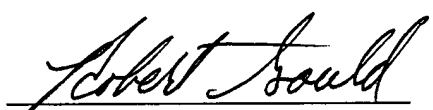
the combination of *Lee* with *Natarajan,* as would be required to make insulated driver electrodes obvious. Consequently, Applicants request that the basis for this rejection be reconsidered and the rejection be withdrawn.

Claim 49 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Lee, Natarajan* and *Weinberg,* and further in view of *Satyapal et al.* (U.S. Patent No. 5,879,435). Claim 49 includes the limitation requiring an insulated driver electrode and is not obvious for the reasons set forth above for independent Claims 1, 14, 19, 31, 34, 45, 50 and 53. Specifically, there is no motivation to combine *Lee* with *Natarajan,* or with *Weinberg* and *Satyapal* in such a manner as to obtain the claimed invention which requires, among other things, an insulated driver electrode. Accordingly, Applicants respectfully request that the obviousness rejection of claim 49 be reconsidered and withdrawn.

Applicants submit that independent Claims 1, 14, 19, 31, 34, 45, 49, 50 and 53 are allowable in their present form. In addition, the remaining claims which all depend from these independent claims are allowable for at least the same reasons as the claims from which they depend, respectively. For these reasons, Applicants respectfully submit that the present application is in condition for allowance and earnestly solicit that the application be promptly passed to issue.

The Examiner is respectfully requested to telephone the undersigned if he can assist in any way in expediting prosecution of this application. The Commissioner is authorized to charge any underpayment of fees or credit any overpayment of fees to Deposit Account No. 02-1818 (order no. 112440-713) for any matter in connection with this response, including any fee for extension of time, which may be required.

Respectfully submitted,
BELL, BOYD & LLOYD LLC

BY 

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Dated: September 29, 2005

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Larry D. Johnson
Reg. No. 31,528

U.S. PROVISIONAL PATENT APPLICATION

OF

JIM LEE

FOR

METHOD FOR INCREASING PERFORMANCE OF ION WIND DEVICES

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BACKGROUND OF THE INVENTION

Technical Field

This invention relates generally to ion generators and ion wind devices, and more specifically to an improved method and apparatus for increasing overall performance of ion wind devices.

Background Art

Ion wind devices such as described in Lee U.S. Patent No. 4,789,801 (incorporated herein by reference) provide accelerated gas ions generated by the use of differential high voltage electric fields between an array of one or more emitters and a plurality of collectors (accelerators). The ions are entrained in the ambient bulk gases, causing the gases to flow. Gas velocities can reach as high as eight hundred feet per minute. However, the high voltage electric fields used to generate the gas ions and provide the force necessary for gas acceleration are also responsible for creating molecular dissociation reactions, the most common of which include ozone generated from oxygen when such devices are operating in a breathable atmosphere. It is an object of this invention to provide methods to convert generated ozone back to oxygen in such devices.

The U. S. Food and Drug Administration has determined that indoor, airborne ozone in concentrations above 50 ppb (parts per billion) may be hazardous to humans. NIOSH (National Institute of Occupational Safety and Health) has ruled that indoor concentrations of ozone above 100 ppb may be hazardous to humans. Devices, which utilize high voltage electric fields to generate atmospheric plasma, corona discharge and air ions, are all susceptible to generating the allotropic for of oxygen, ozone. There exists a linear relationship between the level of the high voltage fields and current and the level of ozone concentration in most direct current operated ion wind systems. Also, a linear relationship exists between the acceleration velocity and intensity of the electric fields. Typically, the higher the voltage the higher the acceleration. Since it is desired to have maximum acceleration, methods must be employed to limit or convert unwanted ozone production back to oxygen before it is expelled into the breathable atmosphere.

Ion wind devices that have been specifically designed as air cleaners have also been inherently limited in the amount of particle contamination they can remove. Unlike electrostatic air cleaners that rely upon a motor driven fan to propel air into an ionizing field, the ion wind device utilizes a structured ionizing field as the primary air movement force. This requires molecular ionization levels at many orders of magnitude greater than are used in electrostatic precipitator devices. Consequently, like-charged particles and matter clustered in the air stream inhibit some airflow and precipitation ability of ion wind devices. It is the further object of this invention to teach a method of de-ionizing a large portion of the charged molecules responsible for the resisting forces in the air stream and to improve precipitation efficiency of the charged contaminant particles by accelerating them towards an oppositely charged collector plate array.

Disclosure of Invention

Ion wind devices accelerate gas ions by applying differential high voltage electric fields between one or more emitters and a plurality of collectors (accelerators). The inventive method improves the overall performance of this process by increasing charged particle precipitation, increasing airflow, and reducing the discharge of ozone.

The introduction of additional collector plates downstream from the ionizing source has long been known to increase precipitation efficiency. What has not been known is the effect the additional collectors may have upon the breakdown of ozone and the increase of airflow if uniquely positioned and energized in the air stream.

Ozone cations (O_3^+) are formed at the positively charged emitter element $3O_2 \rightarrow 2O_3$. Nitrogen (N_2^+) cations and oxygen (O_2^+) cations are also produced at the positively charged emitter element. When the molecules of O_3, N_2, and O_2 gain or lose valence electrons from their outer shell, their respective size changes also. For example, non-ionized (neutral) nitrogen has an atomic radius of 0.71 angstroms and oxygen has a radius of 0.66 angstroms. When they gain electrons (become anionic), they will increase in size to 1.71 angstrom units for nitrogen and 1.40 angstrom units for oxygen. In the case of an O_3^+ ozone ion, if we abruptly convert it to O_3 or O_3^- by adding electrons to its L (2p) shell using a high voltage potential it will radically increase in size, become even more unstable, and convert back to oxygen $2\ O_3^+ \rightarrow 3\ O_2^-$. This is accomplished in the invention by placing a charged electrode downstream (Fig. 1) in the ion wind apparatus to accelerate the ozone cations toward the negatively charged collector electrode where they will receive one or more valence electrons to abruptly convert them to a balanced ion or to an anion. Some of the ozone cations will contact the leading edge and surface area of the collector electrode and convert to oxygen without the need for acceleration. However, very few will actually make contact with the negatively charged collector. The down line electrode(s) may be charged with any positive pulsed or DC voltage with respect to the collector from +00 volts to +10,000 volts depending upon the physical configuration of the array and the specific emitter and collector voltages in use. A grounded or negatively charged plate will also act as a direct contact breakdown source to the ozone cation. However, like the random contact made by the ozone cation upon the collector plates, there is the same likelihood only minimal and random contact is made with the down line electrodes. The more positive the voltage potential applied to the down line electrodes without corona occurring, the more effective the rate of chemical conversion to oxygen becomes. Also, a great deal of the nitrogen cation N_2^+ is balanced or converted to an anion N_2^-. This is desirable in most ion wind devices to minimize the output of breathable cations, which are typically nitrogen molecules that make up almost 80% of the atmosphere.

The down line electrode may be either one or more conductive rods or a thin plate material. The differential voltage between the down line electrode should not be high enough to create high voltage break over or corona current since this may create additional ozone as well as damage high voltage circuitry. Each electrode should be equipped with a high voltage series resistor between one and ten megohms to limit peak current and inhibit break over. The higher the series resistance the less likely of voltage break over and incident of corona current. However, higher resistance also will inhibit electron transfer between voltage source and free ions. An optimum series resistance is

dependent upon selected applied voltages, electrode spacing and desired effect. Typically a one megohm emitter series resistor, ten megohm collector series resistance and a 4 megohm down line electrode series resistance are desirable when using +8KV, -8KV and +4KV respectfully in a 1" X 1" X ½" array. The down line electrode should be positioned equidistantly from and between the collector plates. The position of the electrode from the rear, air discharge, point of the collector plates toward the emitter element is voltage dependent. Under no circumstances may the down line electrode be positioned and/or charged in such a manner as to distort (bend) the primary voltage gradient. Typically, a charged electrode configuration will not exceed +4,000 volts DC and extend beyond the halfway distance from the end of the collector plates toward the emitter element. Deeper upstream penetration toward emitter element is possible at reduced electrode voltage. However, positioning of any electrode, charged or not, too close to the leading edge of the collector plates will alter primary balanced lines of force with the result of reduced airflow. Utilizing a DC voltage source for the collector and down line electrode, which is poorly filtered is also desirable. The ripple voltage acts to further excite the accelerated movement of the ozone cation resulting in additional molecular disassociation.

Ion wind devices do not rely upon a motorized fan to force charged airflow through a collector array. Contrarily, airflow is achieved by charging air molecules, N_2 and O_2 , and repelling the air ions within a balanced voltage gradient, while simultaneously attracting some of them to an oppositely charged element (collector). Therefore, the existence of a heavily populated cationic field of molecules downstream from the source of cation production inhibits unrestricted airflow (Fig. 2). The down line electrode reduces their like-charge effect by accelerating a large amount of the nitrogen cations toward a negatively charged field and element where their valence may be balanced or reversed. The acceleration of atmospheric ions toward an oppositely charged collector is far more effective than random contacts with a grounded or negatively charged electrode.

As air is drawn into the emitter area of the ion wind device, so too are small particles of pollen, airborne viruses, spores, miscellaneous air pollution, etc. These materials, particularly in the size range of .1 micron to 10 microns, are also either directly ionized or are attached to the charged oxygen and nitrogen. By virtue of their relatively large mass and momentum induced by acceleration from transverse electric fields many are collected upon the surface of the oppositely charged collector plates before they can exit the array. To increase the number of collected charged particles, various schemes have been applied for some time. Principally, increasing collector surface area, increasing collector surface voltage level, and reducing air velocity have been the most common methods in use by ion wind devices.

The addition of a positively charged down line electrode exerts a repelling force upon the positively charged particles. A positive high voltage field accelerates a positively charged particle, or particle cluster, toward a negatively charged plate. Typically, a collector plate area A must be A^2 to double particle precipitation efficiently. The addition of a down line +4KV plate electrode having an area of less than A/2 will also double particle precipitation efficiency. As the air stream is evacuated more quickly of charged particles, gaseous ions are allowed to flow with less opposition (Fig 3,4). The result is increased airflow.

A down line electrode plate or rod element, which is isolated from ground or a voltage source, will accumulate a surface charge proportional to air stream ion polarity and density. Also, a down line electrode which is connected to ground via a high voltage capacitor will accumulate a large surface charge proportional to air stream ion density and polarity. While either configuration offers benefits over having no electrode at all, the benefits are minimal by comparison to having the down line electrodes, which is established with a net positive voltage with respect to adjacent collector arrays, connected to a voltage source.

Finally, reversing polarity of emitter, collector and down line electrode will have similar benefits as described herein. However, using a negative high voltage emitter source generally increases the production of ozone and irregular plasma envelope emissivity at the primary emitter element. Typical high voltage power sources consist of a dual positive and negative half wave voltage multiplier operating with an input frequency of 20,000Hz or above. Typical output voltages +8KV, -8KV and +4KV, which are derived from the first stage of the two-stage positive voltage multiplier circuit (Fig. 5). Multiplier capacitance values are typically between 220pf and 470pf at 10KV or greater depending upon desired voltage and ripple effect.

REDUCING OZONE

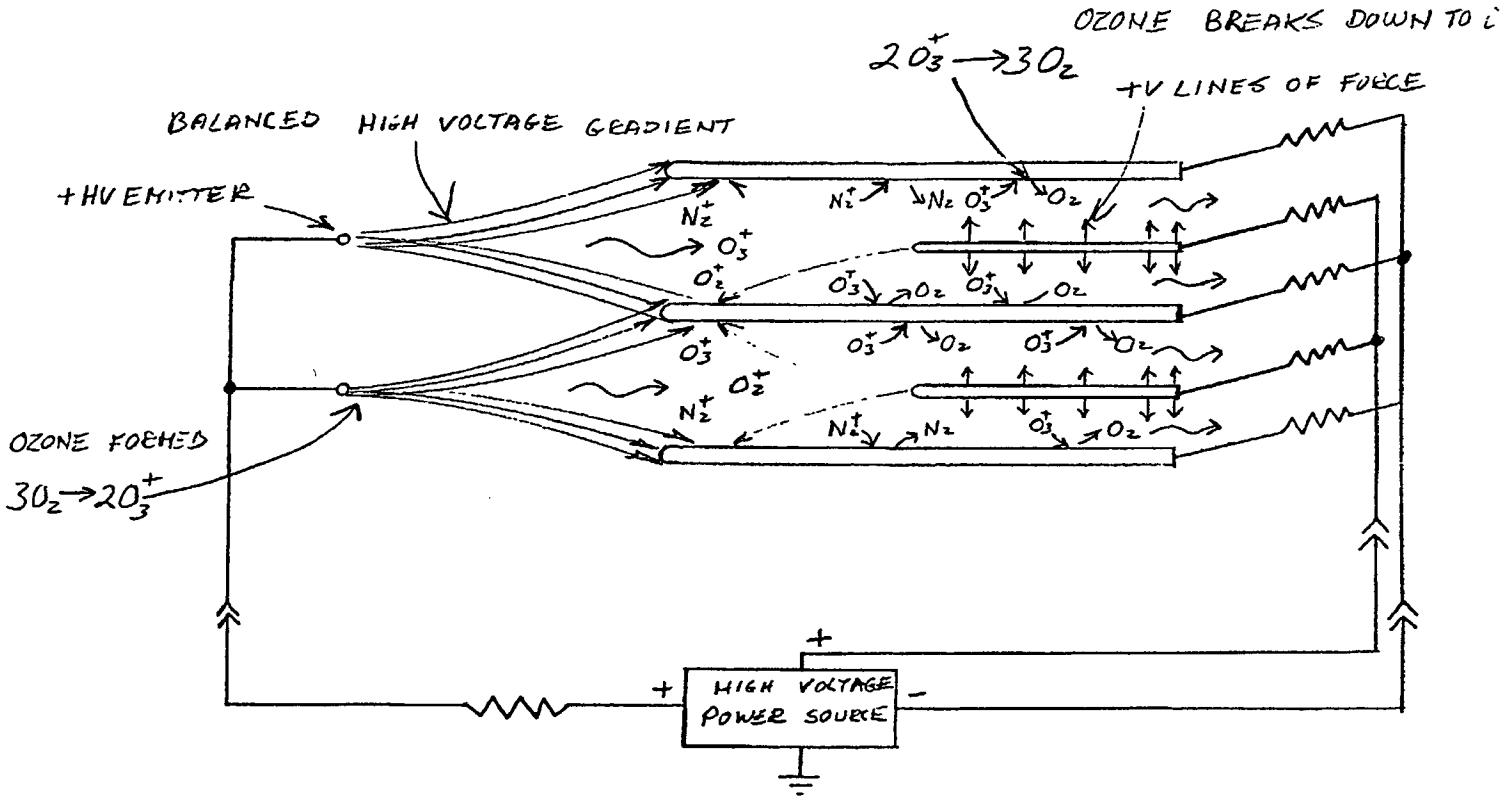


FIG. #1

INCREASING AIR FLOW

LIKE CHARGE RESISTANCE

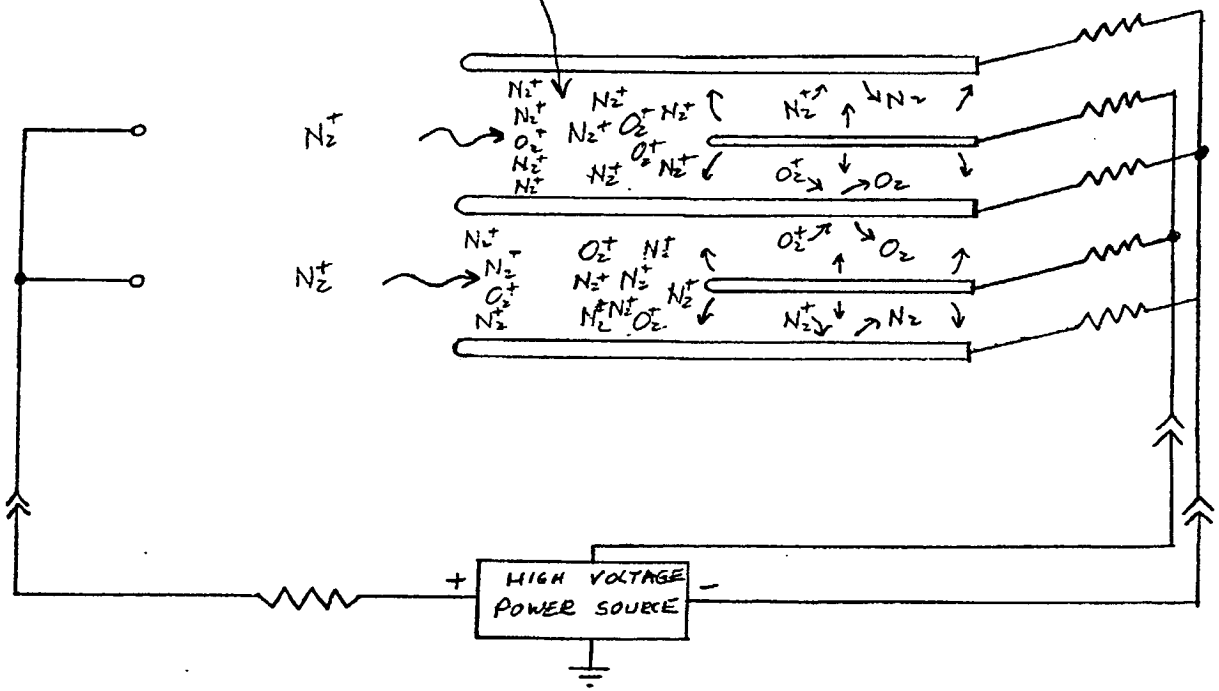


FIG #2

INCREASED CHARGED PARTICLE COLLECTION

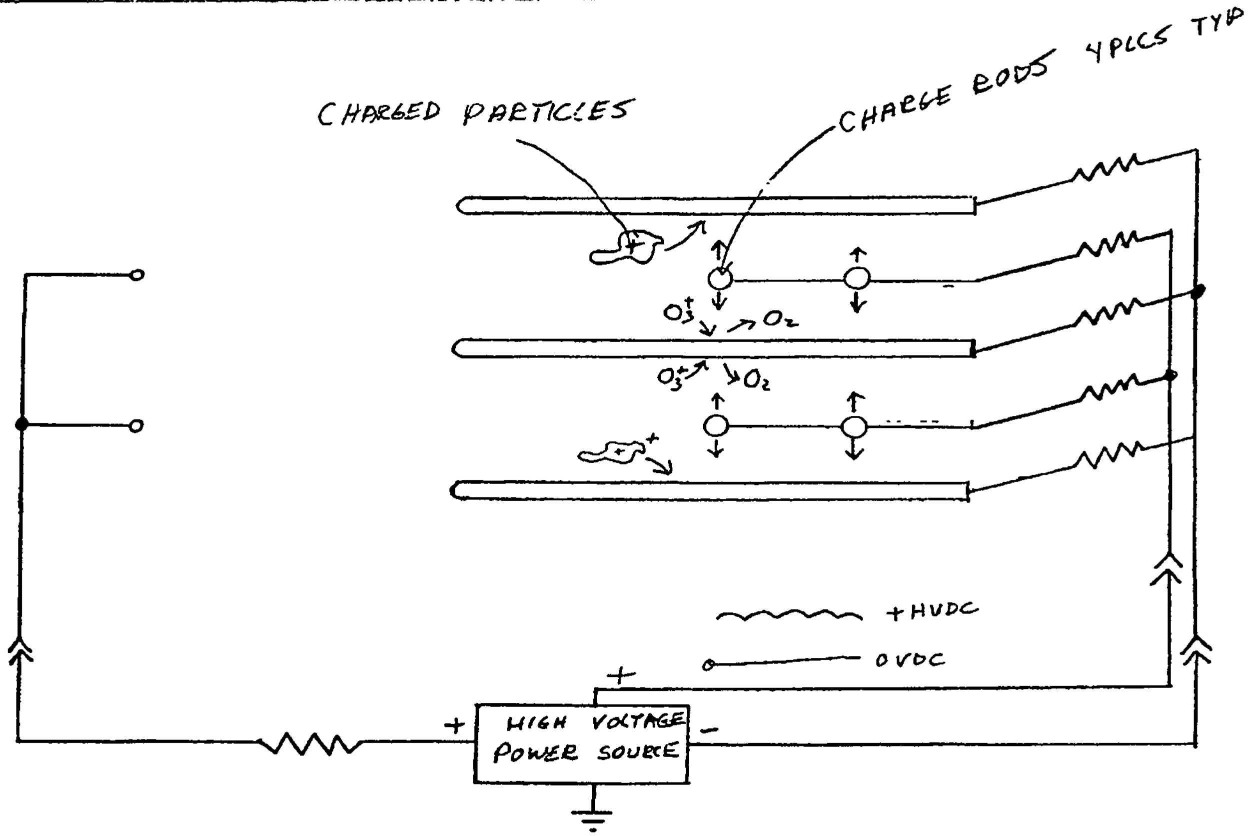


FIG. #3

DOWNLINE ROD ACCELERATORS

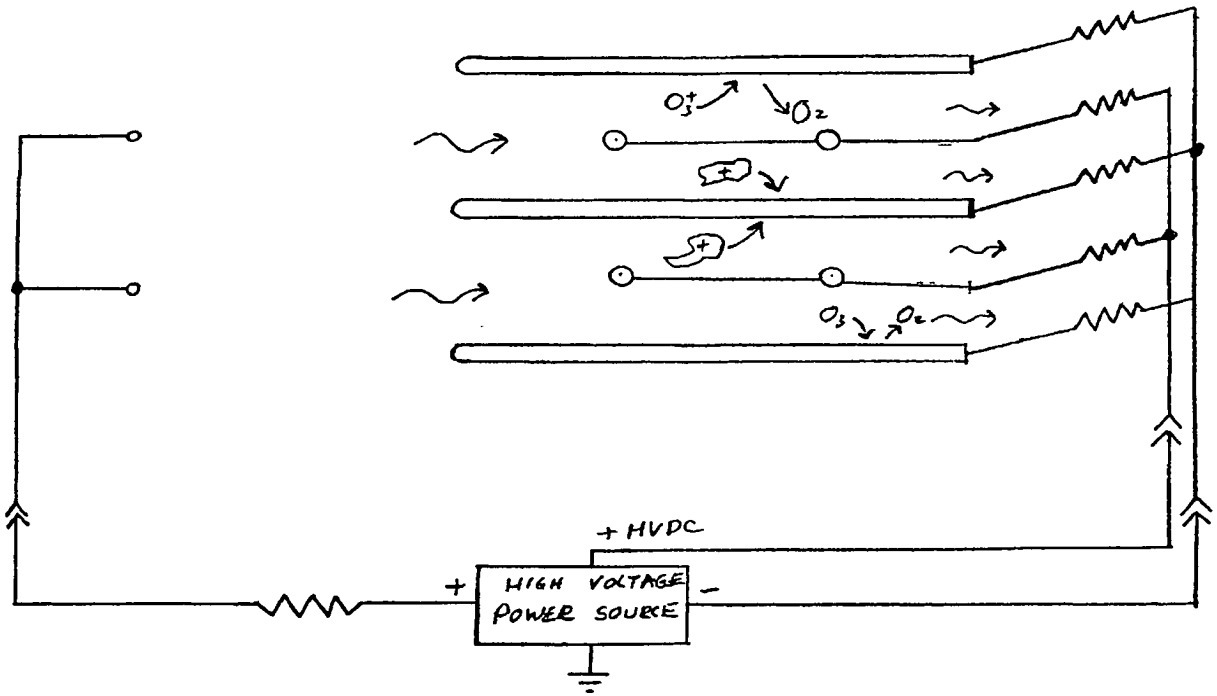
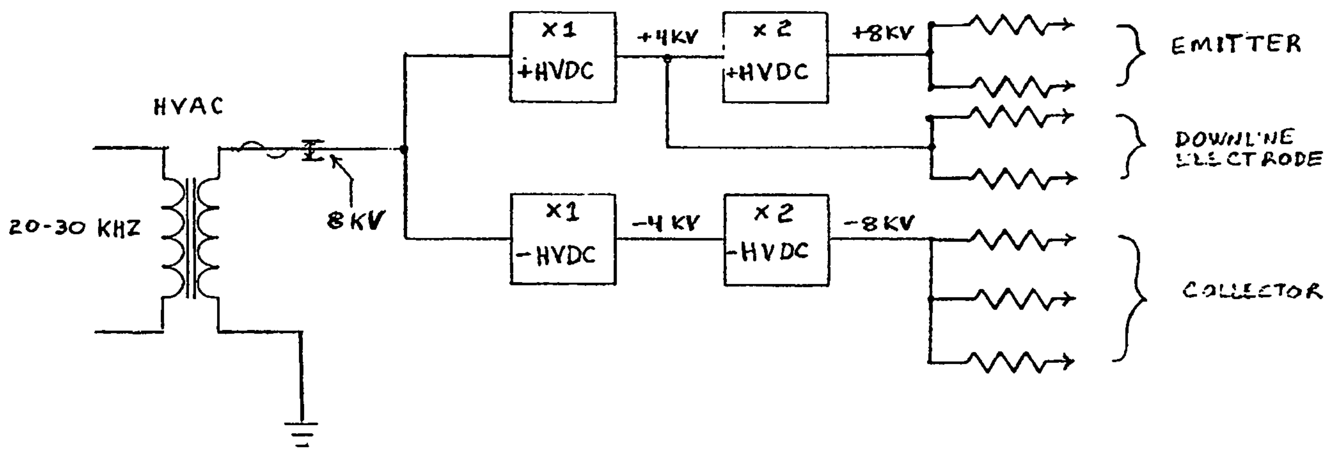


FIG 4



TYPICAL HVDC MULTIPLIER POWER SOURCE

FIG. # 5.